California Public Utilities Commission Workshop 9:30 AM May 11, 2015

MAOP determination and background of 49 CFR § 192.619(c)

US DOT PHMSA Office of Pipeline Safety

Topics Areas for Discussion

- Definitions from §192.3 and §192.5
- relevant code sections of MAOP determination
- background of 49 CFR § 192.619(c)

Definitions

§ § 192.3 & 192.5

Pressures

- MAOP - "Maximum Allowable Operating Pressure" means the maximum pressure at which a pipeline or segment of a pipeline may be operated under this part.
- MOP - "Maximum Actual Operating Pressure" means the maximum pressure that occurs during normal operations over a period of one year.
- OP - "Operating Pressure" means the pressure on the pipeline at any given time. This is usually the set point of the Regulator.

Class Location Definition §192.5

- The class location unit is an onshore area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline.

- The class location is determined by the buildings in the class location unit. For the purposes of this section, each separate dwelling unit in a multiple dwelling building is counted as a separate building intended for human occupancy.

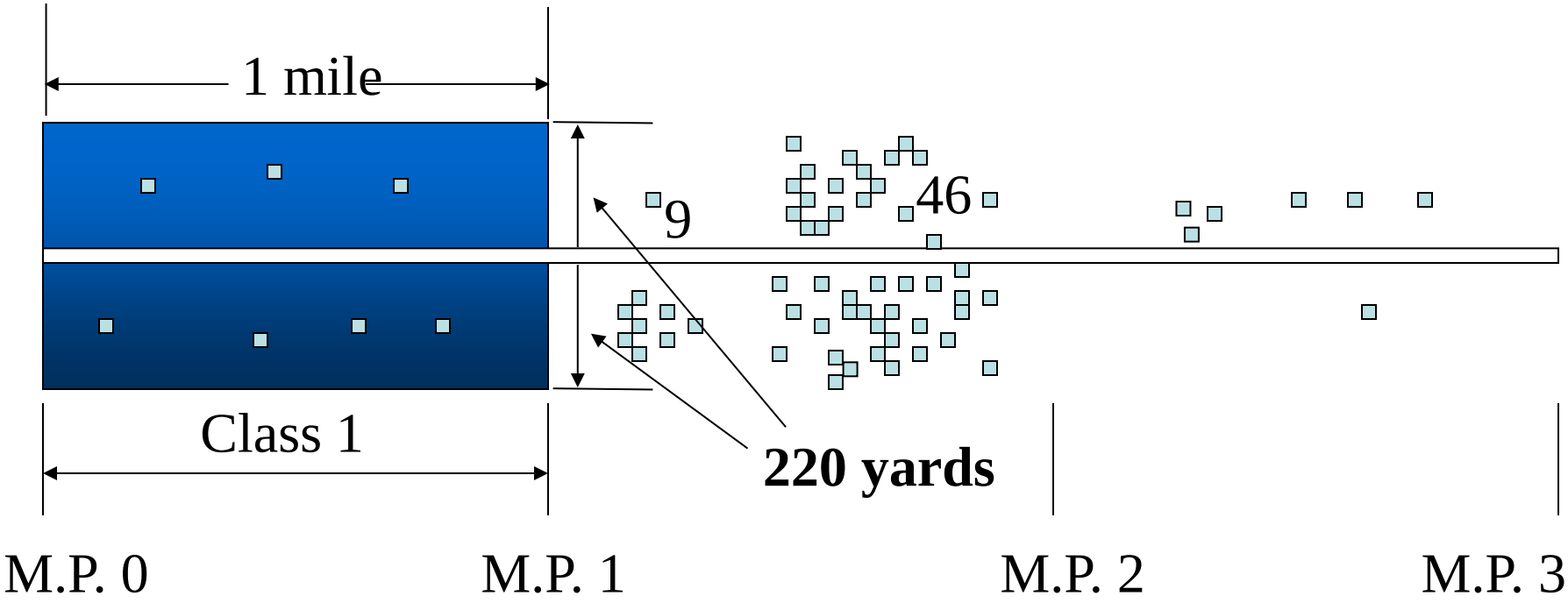
Class Location Unit

- Class 1 = 10 or less buildings intended for human occupancy or an offshore area.
- Class 2 = Greater than 10 but less than 46 buildings intended for human occupancy.
- Class 3 = 46 or more buildings intended for human occupancy; or

Class Location Unit

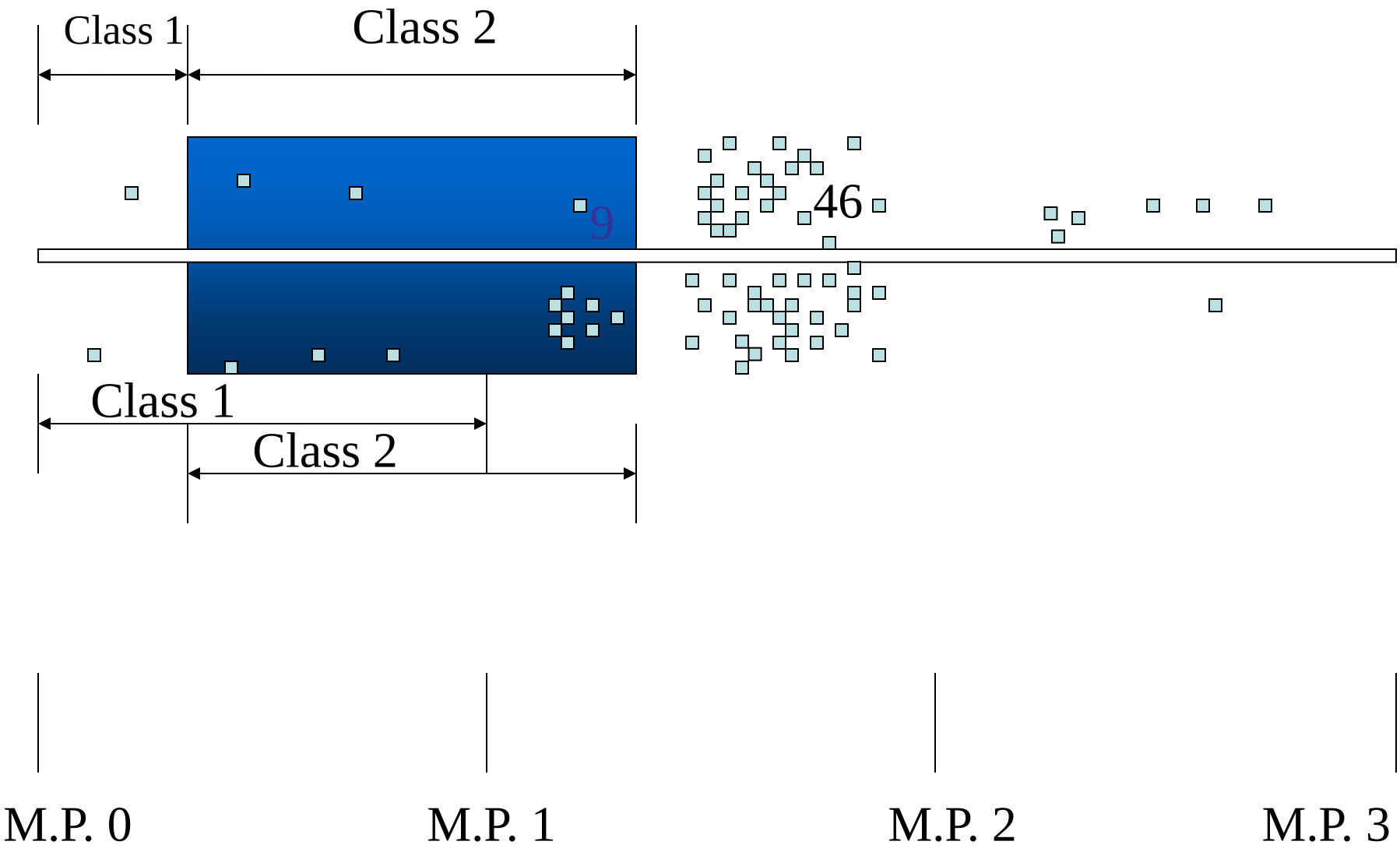
- Class 3 - where the pipeline lies within 100 yards of either a building or a small, well-defined Outside Area occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12-month period
  - Playground
  - Recreation Area
  - Outdoor Theater
- Class 4 - where buildings with four or more stories aboveground are prevalent.

Class Location Determination



M.P. = Mile Post

Continuous Sliding Mile



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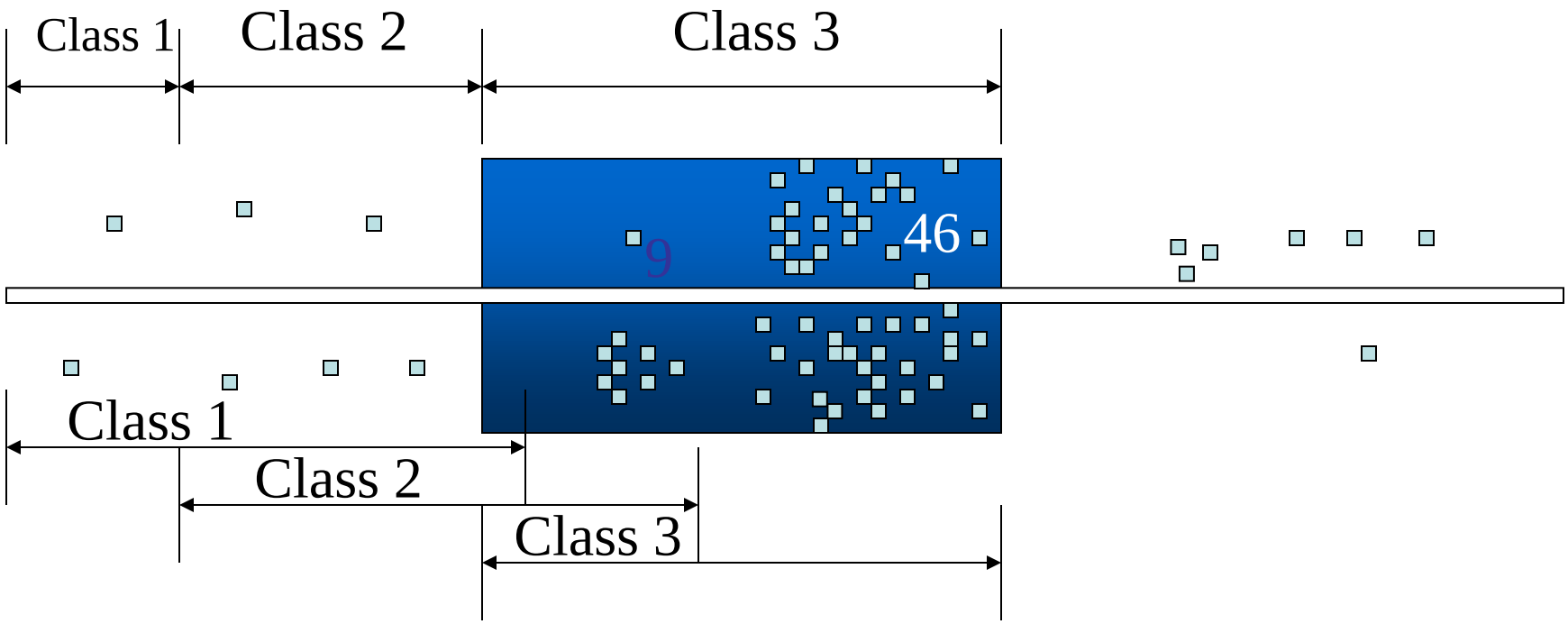

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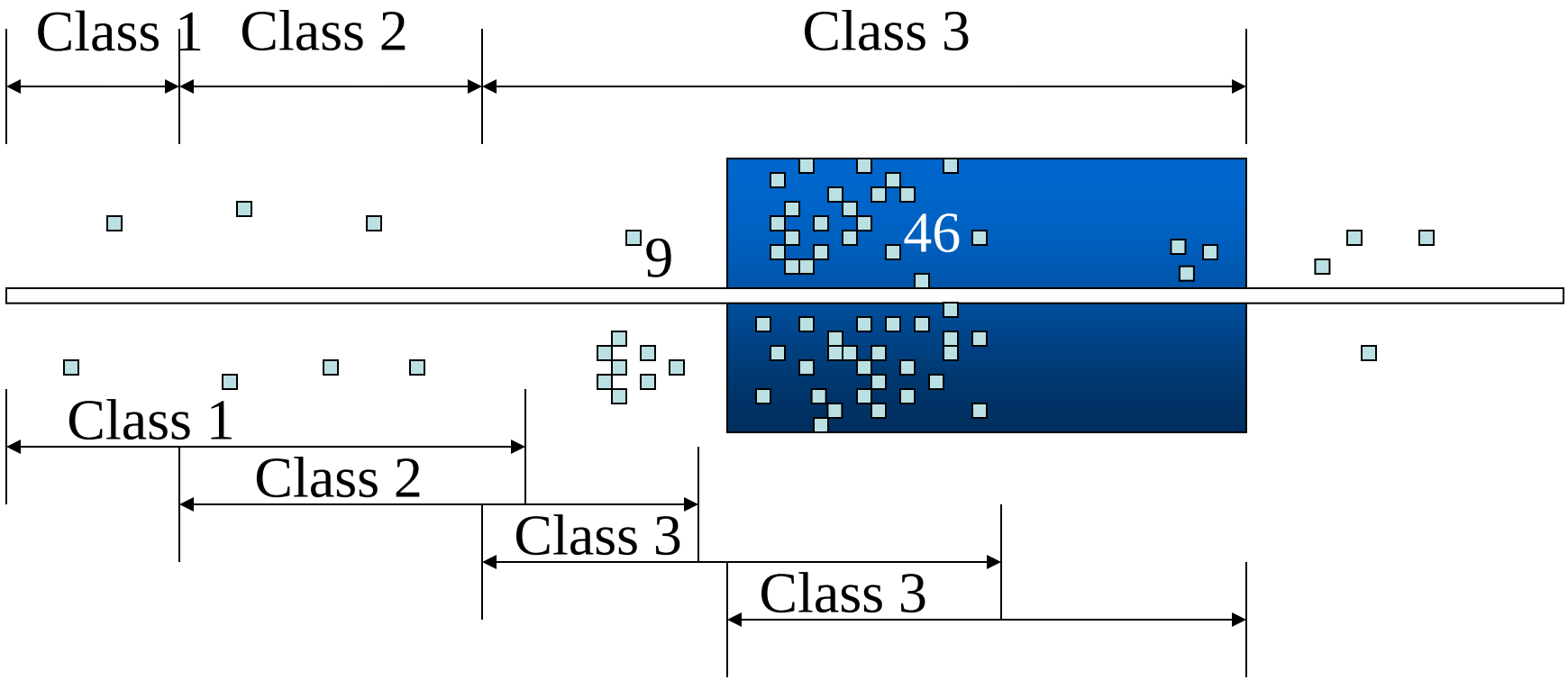

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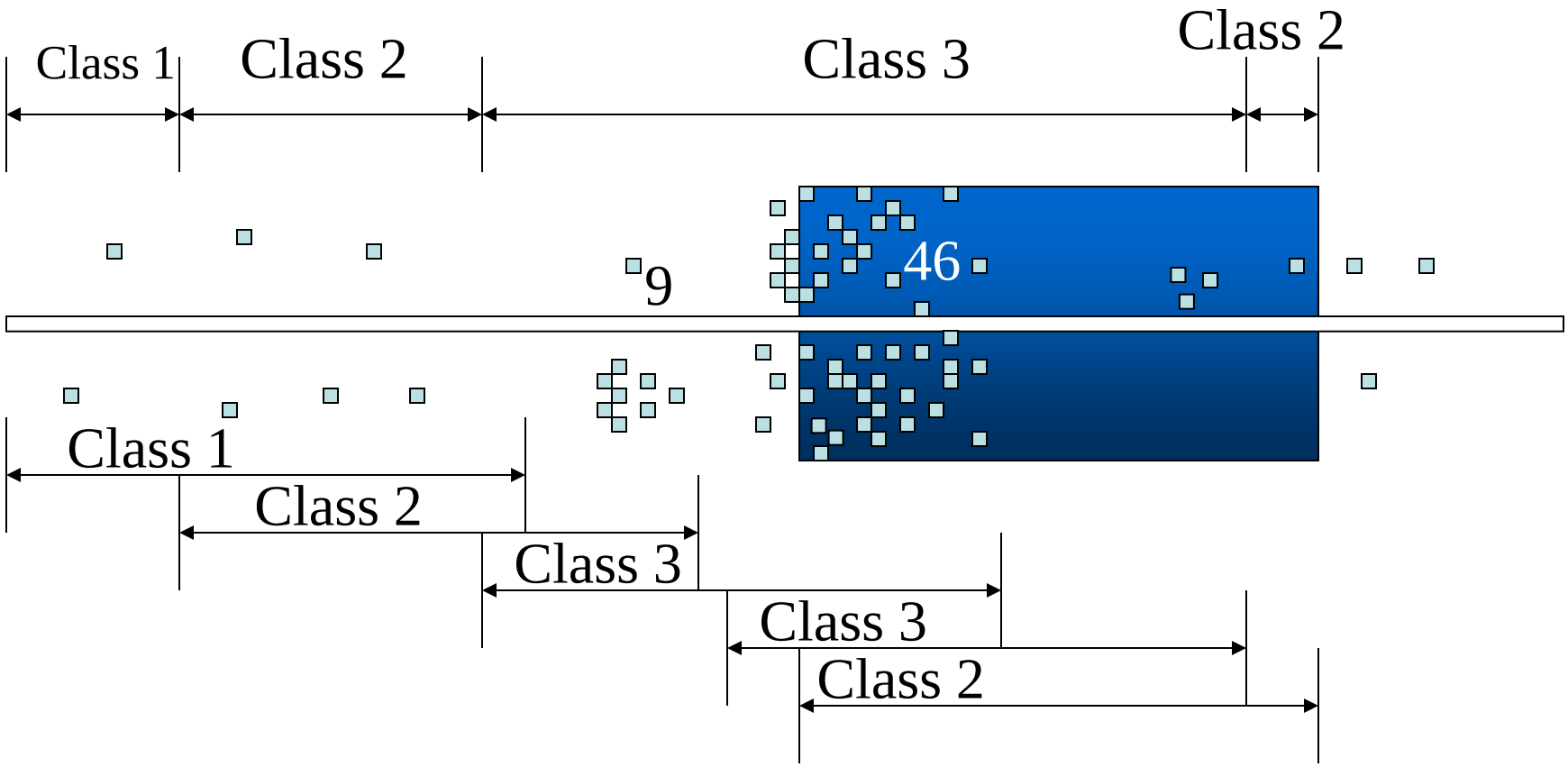

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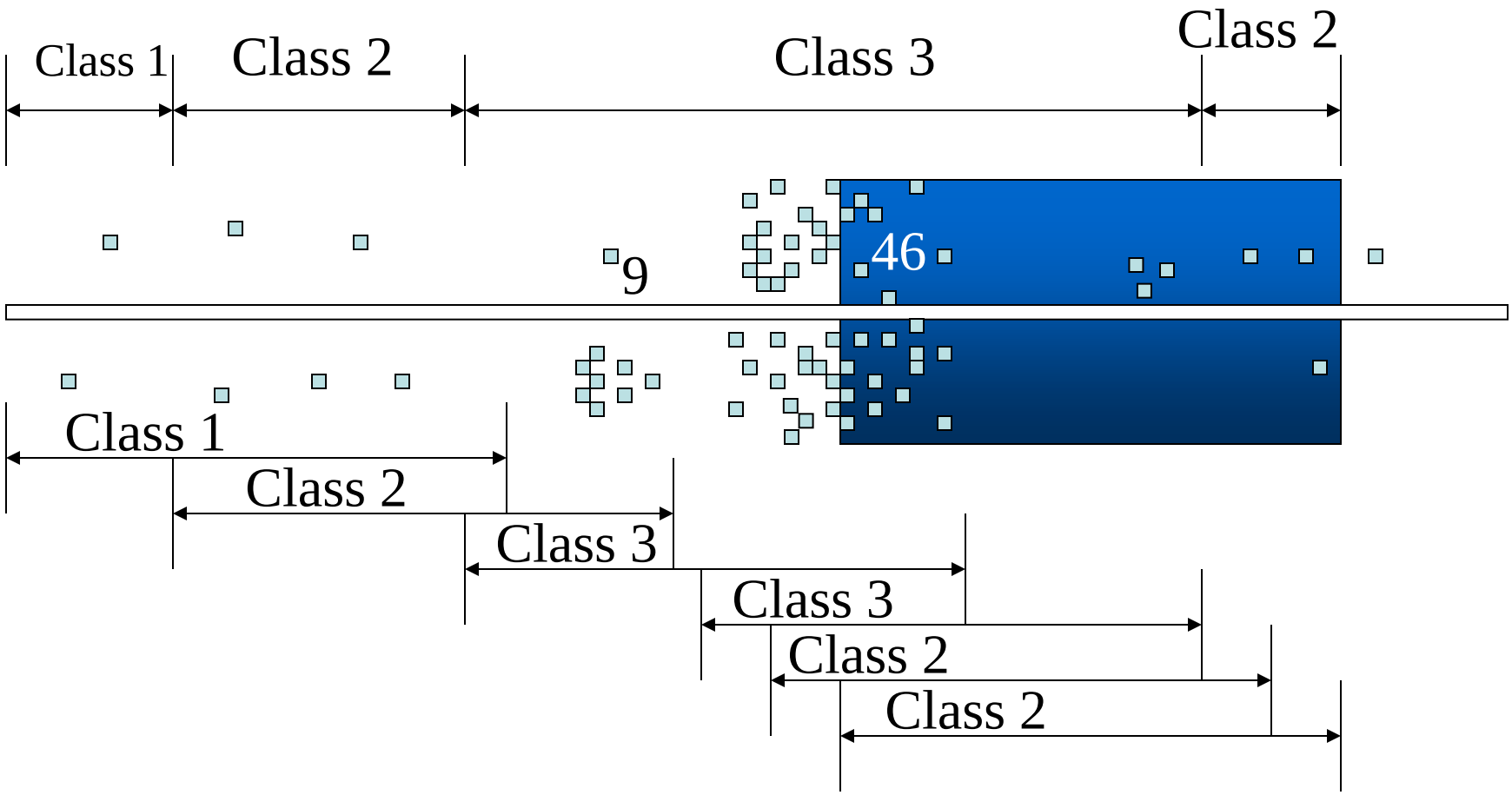

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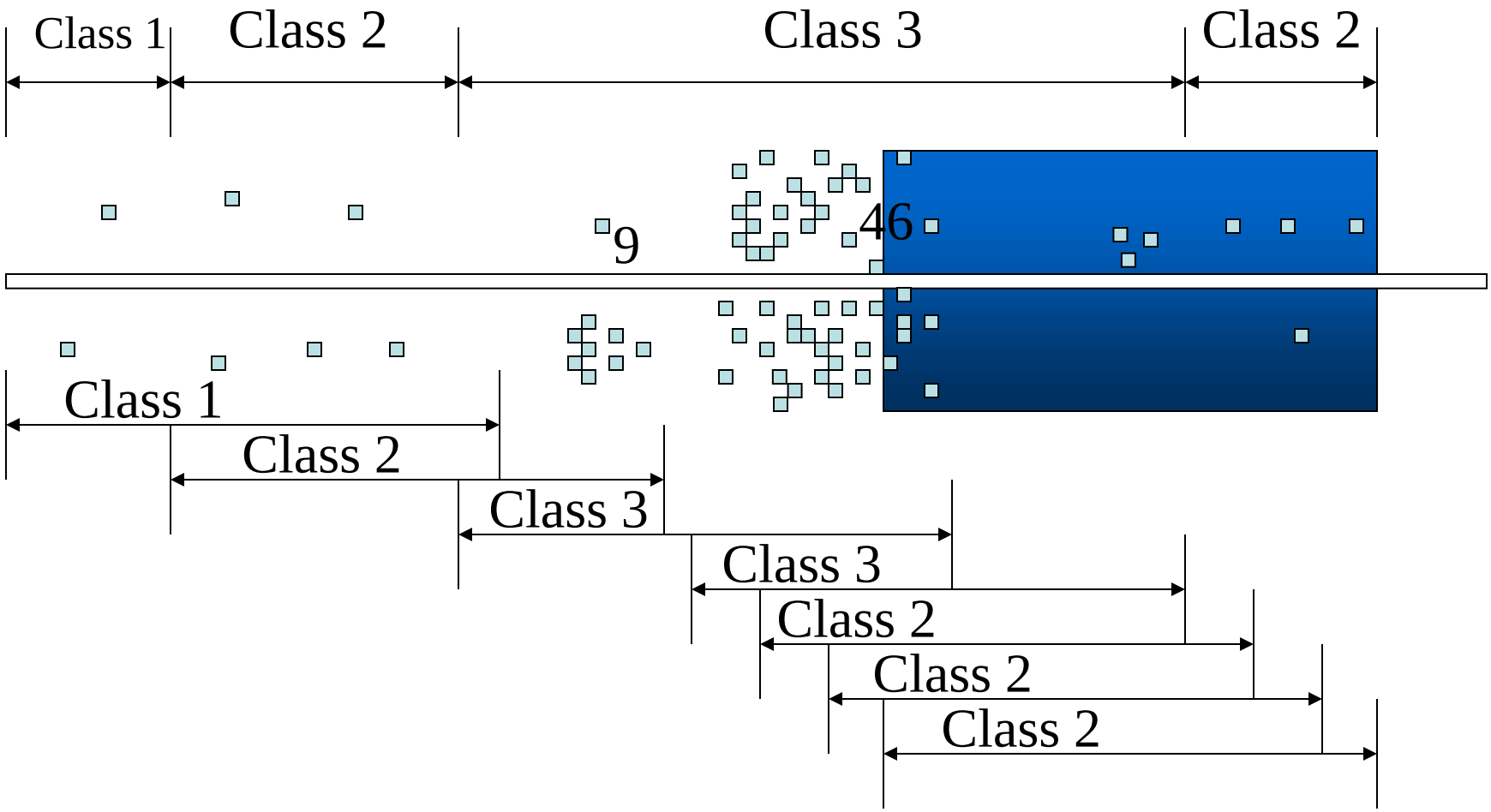

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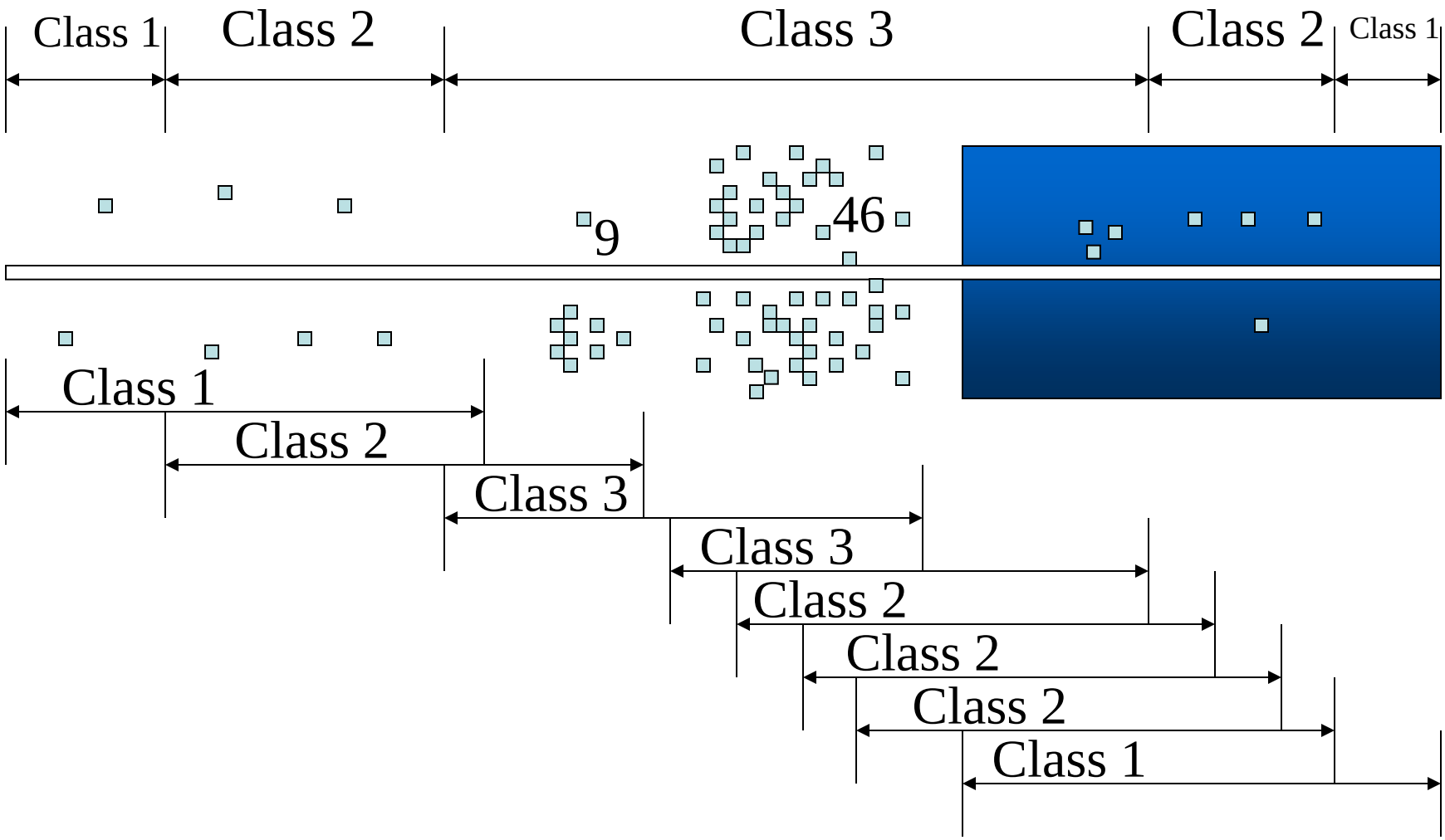
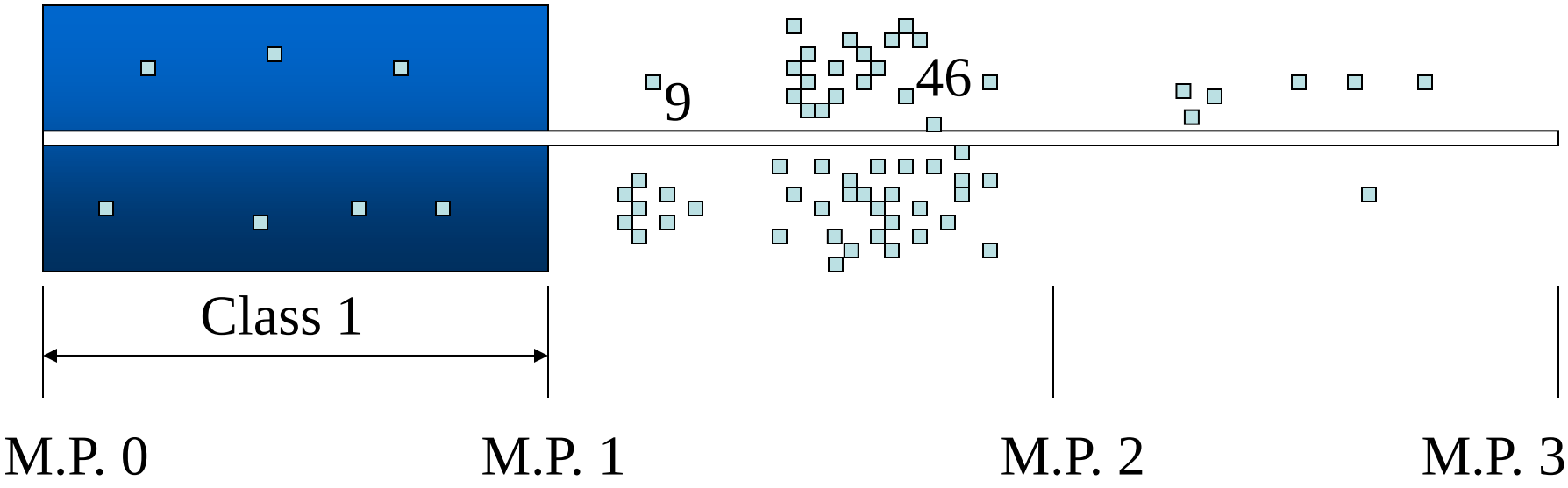


Class Location Determination (Mistake)



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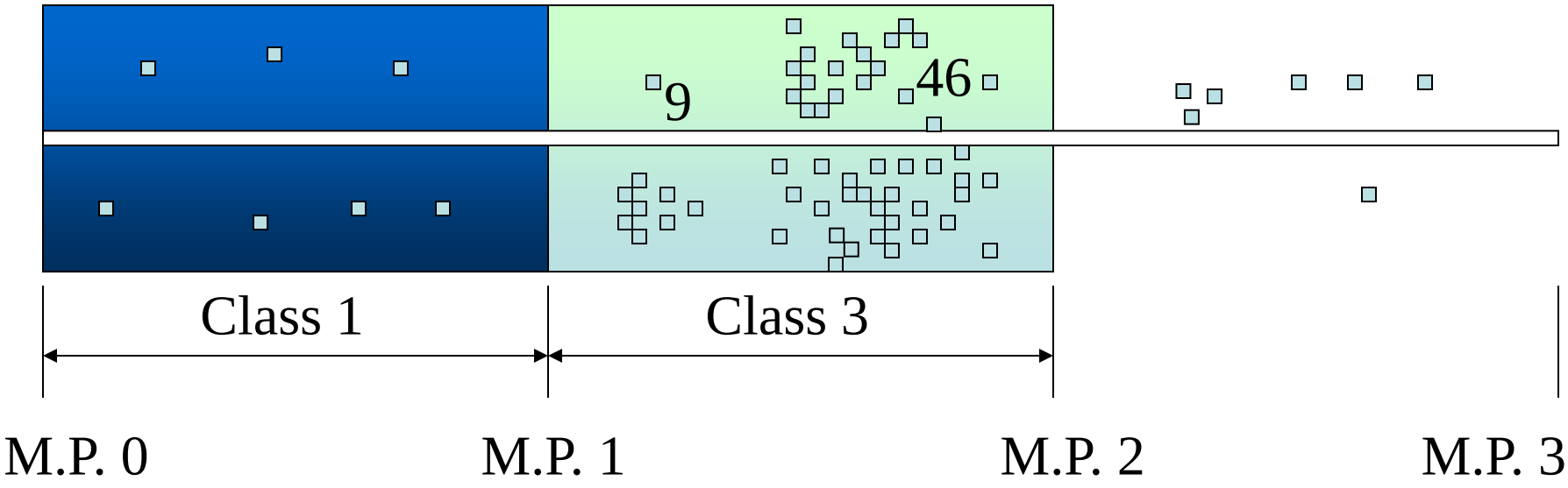

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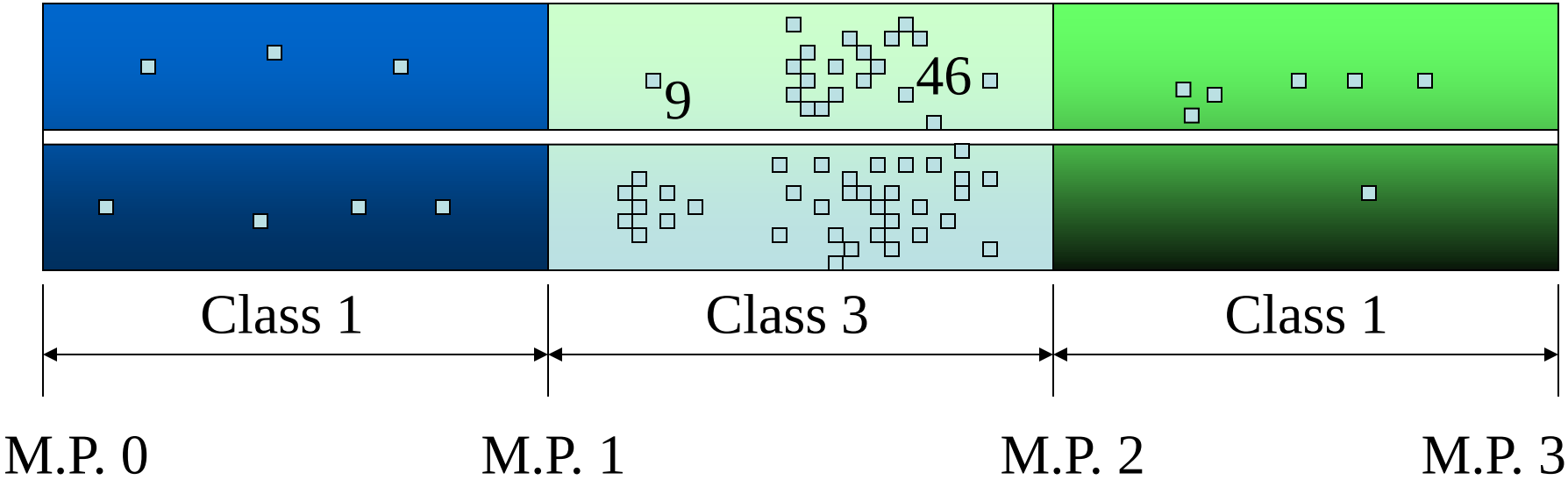

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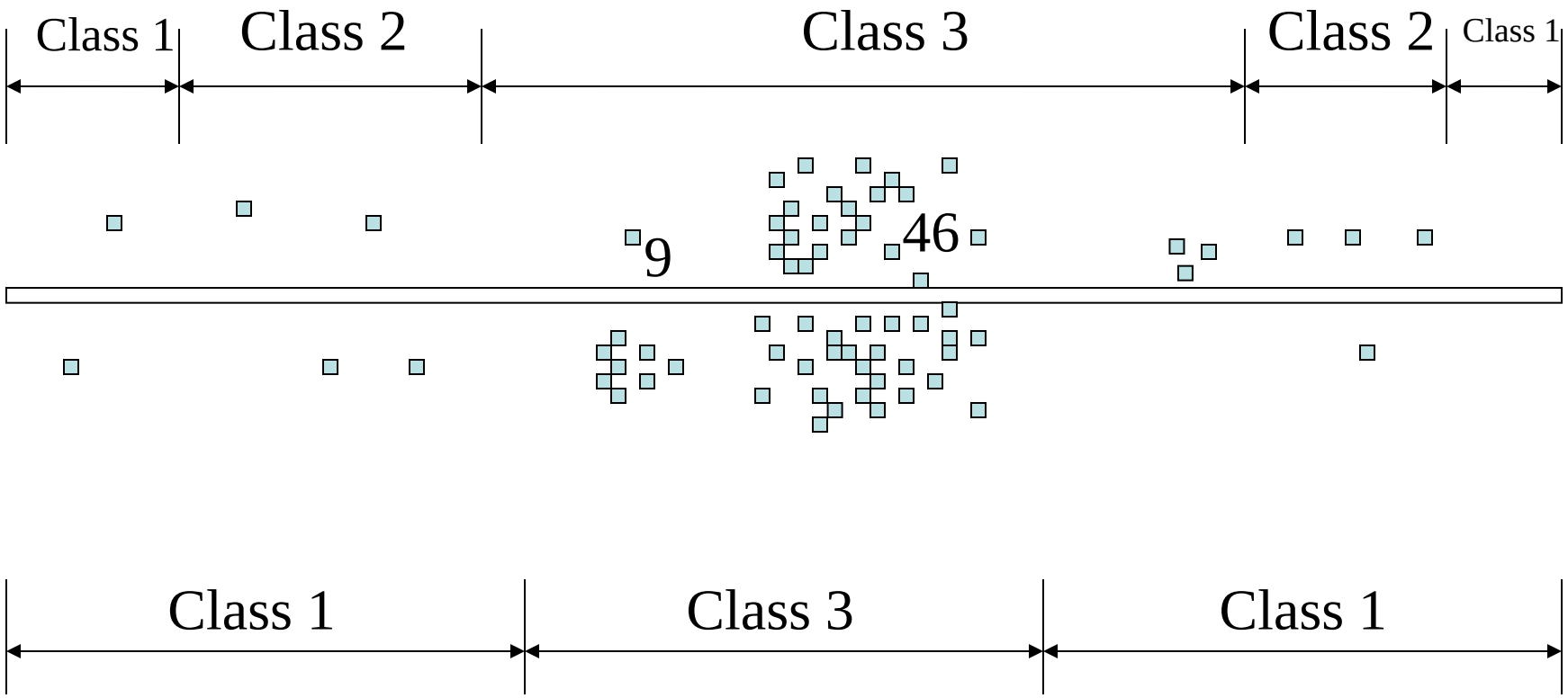


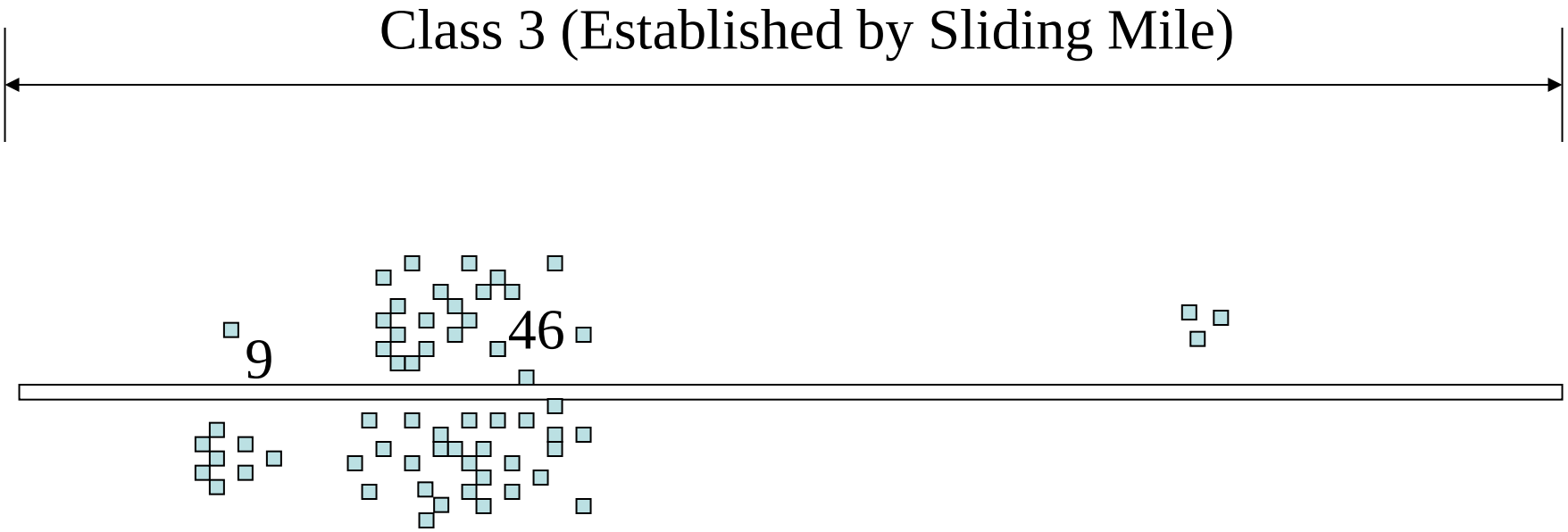
End-to-End Mile (Mistake)

Clustering

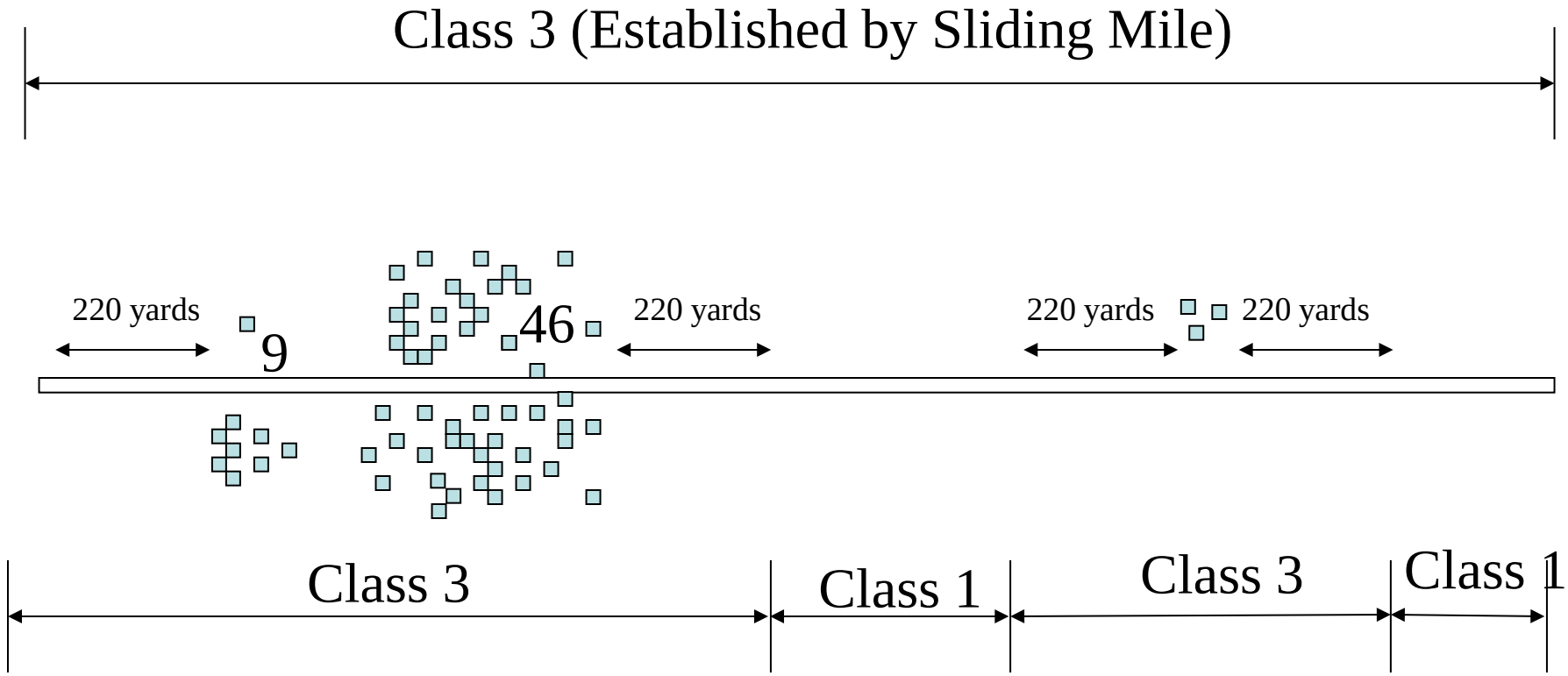
- In §192.5 under paragraph (c), an operator is given the ability to "cluster" or reduce the amount of pipe that is affected by a higher class location.
- A different class location of a segment of pipe is affected by several different areas of the regulations. These include design, operations and maintenance. The regulation states:
- The length of Class locations 2, 3, and 4 may be adjusted as follows:

(1) A Class 4 location ends 220 yards (200 meters) from the nearest building with four or more stories above ground.
(2) When a cluster of buildings intended for human occupancy requires a Class 2 or 3 location, the class location ends 220 yards (200 meters) from the nearest building in the cluster.

Clustering

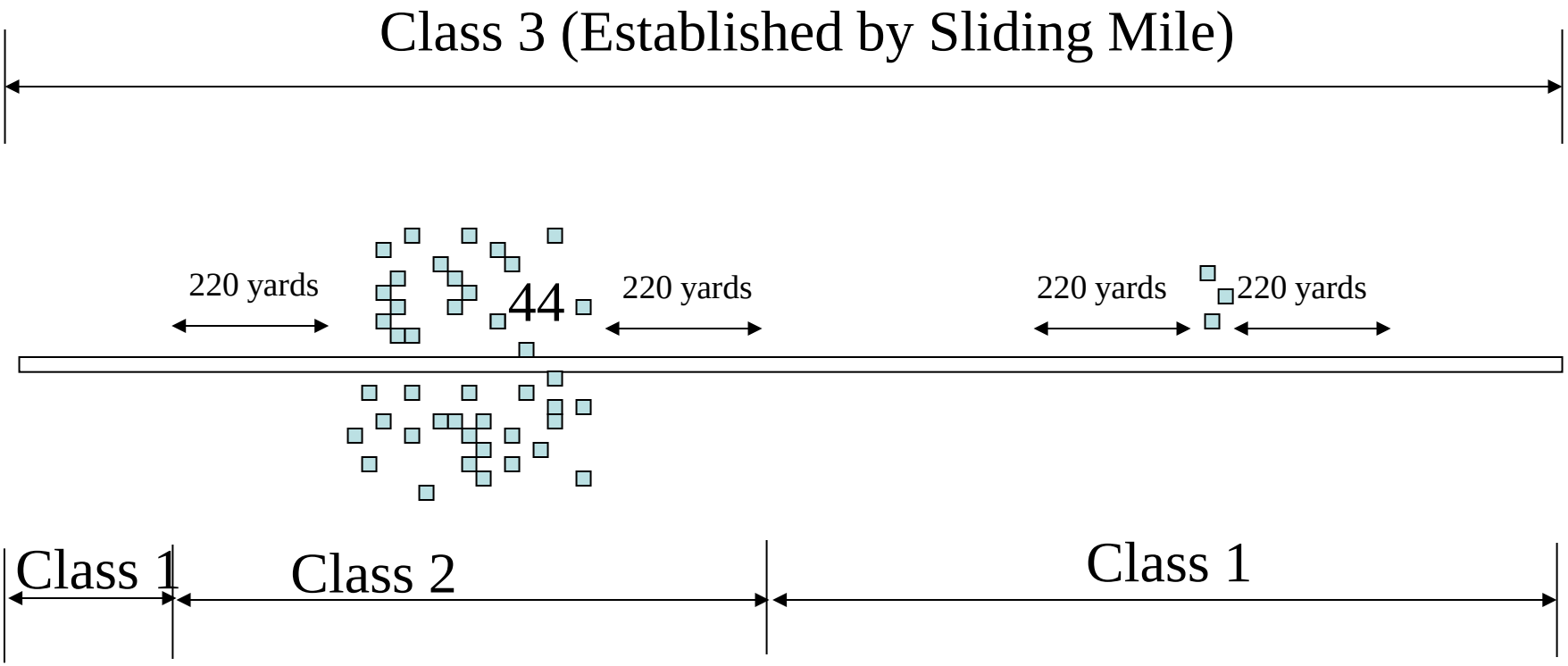


Clustering



A commonly occurring issue with implementation of clustering rules is the operator's omission of the extra 220 yards from the last building in the class location unit.

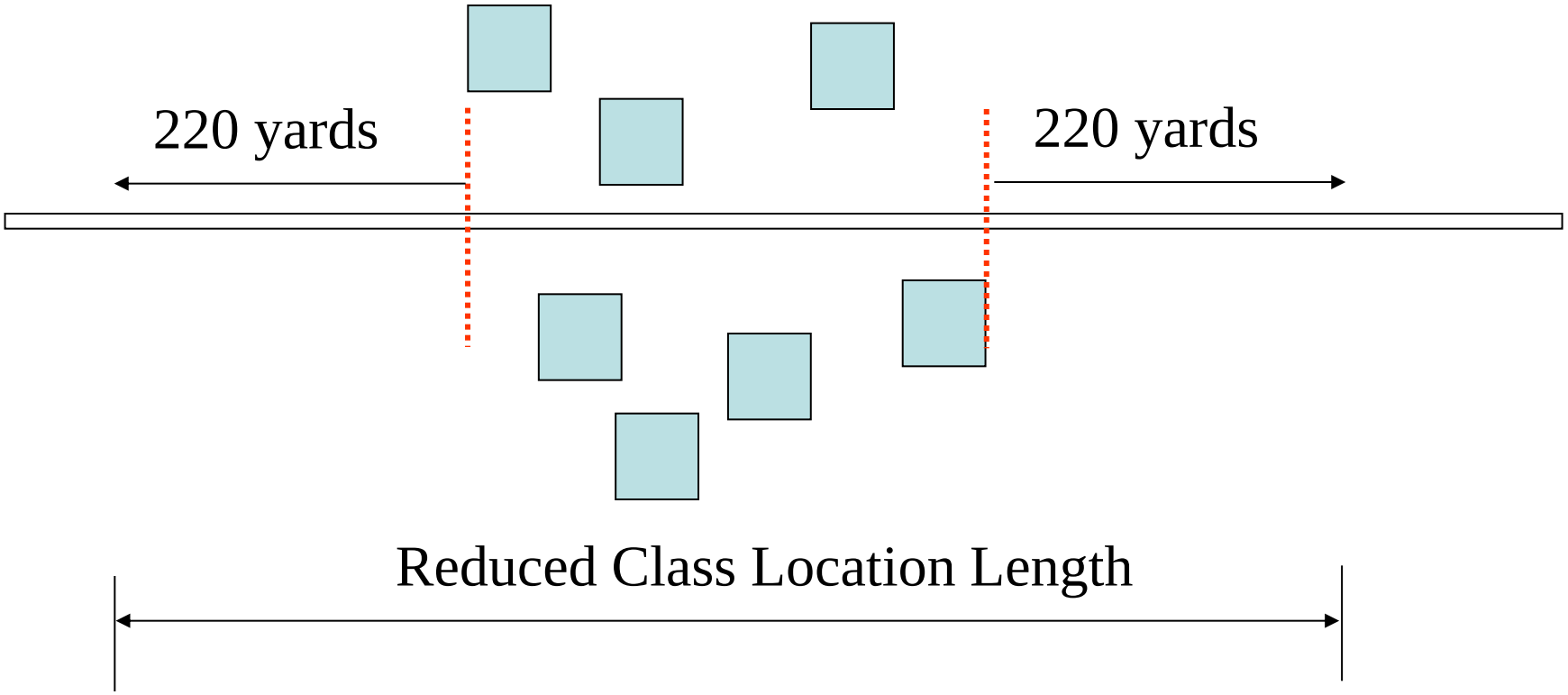
Incorrect *Clustering Application*



The ***length*** can be adjusted, not the actual class. The regulation does not allow the operator to downgrade a class location after it has been established by the sliding mile

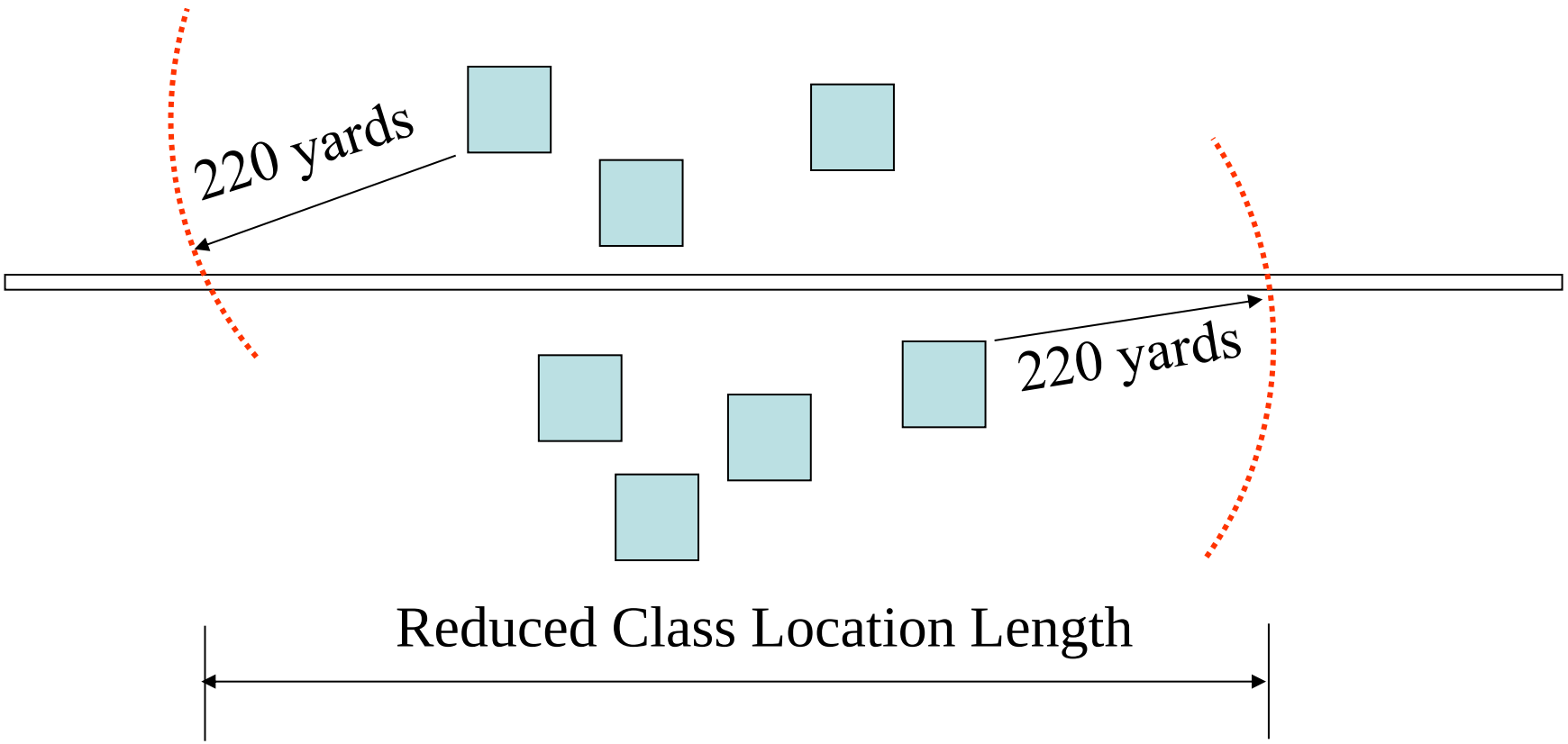
Clustering Limits

Perpendicular Method



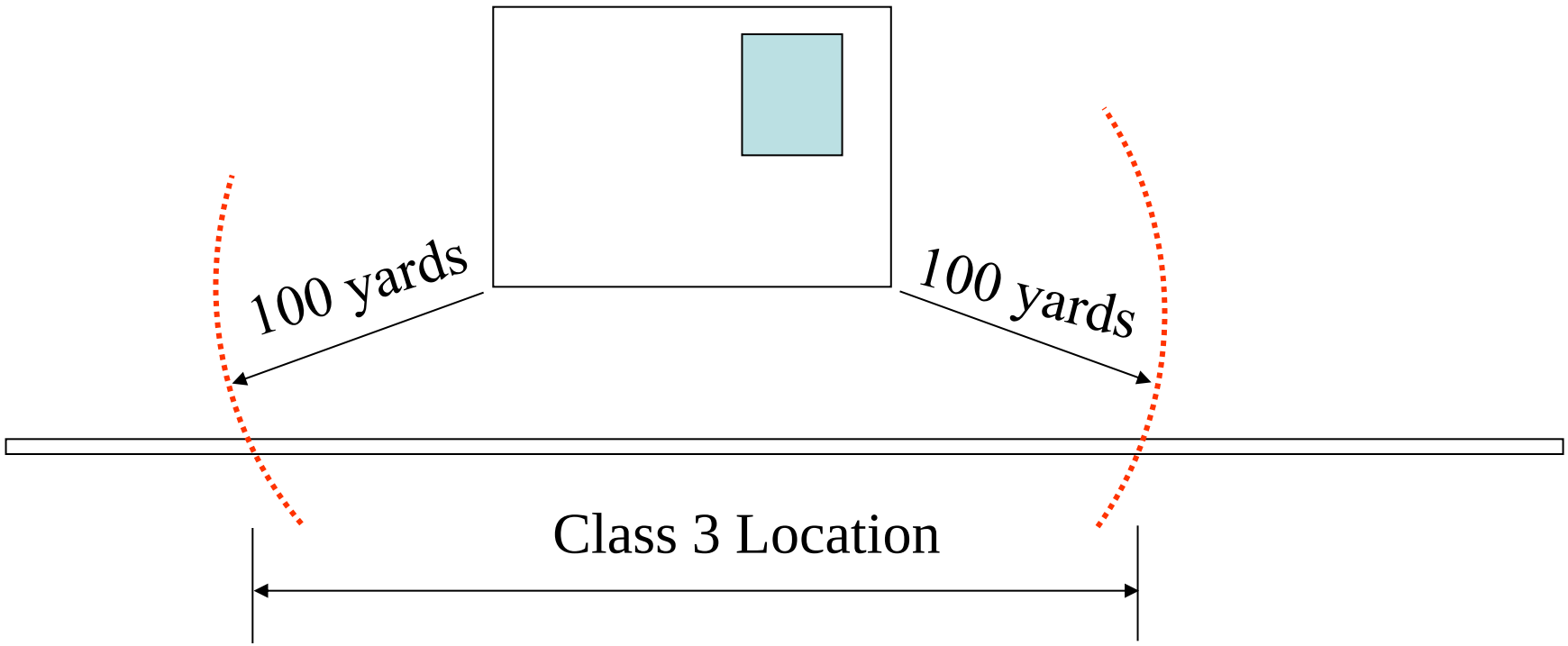
Clustering Limits

Arc Method



Class 3 – Small Well Defined Area

School with Playground



§192.619 – MAOP Calculations- All Pipelines

Lowest of the following:

- (a)(1) Design
- (a)(2) Test Pressure
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

§192.619 - All Pipelines

Lowest **of the following:**

(a)(1) Design ←

(a)(2) Test Pressure

(a)(3) MOP during the 5 years preceding July 1, 1970

(a)(4) Maximum Safe Pressure determined by the Operator

Design of Pipe and Components

- Pipe
  - For Steel - §192.105
  - For Plastic - §192.121

- Components
  - Use the Manufacturers Rating established by the Manufacturer - built and tested to standards required by Part 192
  - Examples include Pipeline Tees, Valves, Launchers, Receivers, Flanges, other fabricated assemblies, etc.

§192.105 - Design of Steel Pipe

$$P = (2St/D)(F)(E)(T)$$

- P = Design Pressure
- S = Yield Strength (SMYS)
- D = Outside Diameter
- t = Wall Thickness
- F = Design factor - §192.111
- E = Longitudinal joint factor - §192.113
- T = Temperature derating factor - §192.115

Steel Pipe Specifications

- API 5L, Grade B (35,000 psi SMYS), 8“ Diameter, .322" wall thickness
- P = 2St/D
  P = (2)(35,000)(.322)/8.625
  P = 2613#

Equivalent Pressure at 100% SMYS

§192.107 Yield strength (S) for steel pipe

(a) For pipe that is manufactured in accordance with a specification listed in section I of Appendix B of this part, the yield strength to be used in the design formula in §192.105 is the SMYS stated in the listed specification, if that value is known.

(b) For pipe that is manufactured in accordance with a specification not listed in section I of Appendix B to this part or whose specification or tensile properties are unknown, the yield strength to be used in the design formula in §192.105 is one of the following:

(1) If the pipe is tensile tested in accordance with section II-D of Appendix B to this part, the lower of the following:

(i) 80 percent of the average yield strength determined by the tensile tests.

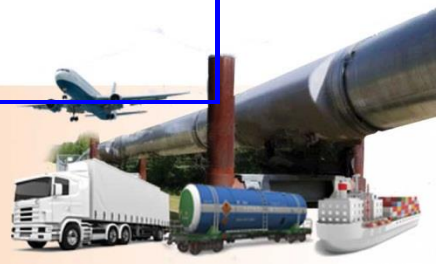
(ii) The lowest yield strength determined by the tensile tests.

(2) If the pipe is not tensile tested as provided in paragraph (b)(1) of this section, 24,000 psi (165 Mpa).

Design Factor (F) from §192.111

$$P = \frac{2St}{D}(F)$$

Class location	Design factor (F)
1	.72
2	.60
3	.50
4	.40



For a Class 3 Location

$$P = \frac{(2)(35{,}000)(.322)}{8.625}\ (0.50)$$

P= 1307#

If this line is built in a class 3 location the derating factor is .50 as illustrated in the table in §192.111.

Longitudinal Joint Factor E

- E = Longitudinal Joint Factor - §192.113
- Usually Not a Factor - Be Sure to Check!!
- For almost all of the different types of manufacture processes of pipe and seams the derating factor (E) is 1.00, with the exceptions of furnace butt-welded pipe or pipe made from an unknown standard (below).

API 5L	**Furnace butt welded**	**0.60**
Other	**Pipe over 4 inches (102 millimeters)**	**0.80**
Other	**Pipe 4 inches (102 millimeters) or less**	**0.60**

Temperature Derating Factor T

- T = Temperature Derating Factor - §192.115
- Temperature (T) doesn't become a factor until the gas stream reaches above 250°F

Gas Temperature in degrees Fahrenheit (Celsius)	Temperature derating factor (T)
250 (121)or less	1.000
300 (149)	0.967
350 (177)	0.933
400 (204)	0.900
450 (232)	0.867

Note that coating issues can develop above 130°F

Components

- In determining MAOP we also have to look at other components other than just pipe. Subpart D addresses design of components and the standards in which they need to be manufactured to.
- We go through and look at every component in the pipeline system or segment. The design limitation is the manufacturer's operating pressure rating of the component, and examples include the following:
  - **1000 WOG Valve – 1000 psi**
  - **ANSI Class 300 Flange – 720 psi**
  - **ANSI Class 600 Valve – 1440 psi**

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 720#
  - Components = 720#
  - Pipe = 1307#
- (a)(2) Test Pressure
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

Testing - Steel > 100 psi §192.619(a)(2)(ii)

	Factors[1], segment		
Class location	Installed before Nov. 12, 1970	Installed after Nov. 11, 1970	Covered under §192.14
1	1.1	1.1	1.25
2	1.25	1.25	1.25
3	1.4	1.5	1.5
4	1.4	1.5	1.5

Note that the factor is 1.25 (not 1.1) when a building is within 300 feet of a pipeline for a class 1 or 2 location per §192.505(a)

Test Pressure / Factor

- Assume a Test Pressure in 1964 of 1500 psi
- For Class 3 – Factor is 1.4
- 1500/1.4 = 1071 psi MAOP

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 720#
- (a)(2) Test Pressure = 1071#
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

MOP

- High MOP during 5 years preceding 7/1/70

  Assume Operating Charts show high MOP is in 1968 at 850 psi

- Unless:
  - Tested in accordance §192.619(a)(2) after July 1, 1965 OR
  - Uprated in accordance with Subpart K of this part.
- The MOP pressure is not a limiting factor if the line was pressure tested in the 5 year window or has gone through an uprate during this window.

MOP

- It is important to understand how the high pressure was established.
- If the line was "blocked in" to establish the high pressure, then the MOP is established for the entire pipeline.
- If the high pressure was established during normal operations, then a pressure gradient was present between the inlet and outlet ends of the pipeline. If this method is used, then pressure control equipment must be in place so that the original pressure gradient is not exceeded.

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 720#
- (a)(2) Test Pressure = 1071#
- (a)(3) MOP = 850#
- (a)(4) Maximum Safe Pressure determined by the Operator

§192.619 (a)(4) Maximum Safe Pressure

- The pressure determined by the operator to be the maximum safe pressure after considering the history of the segment, particularly known corrosion and the actual operating pressure.
- The Maximum Safe Pressure determination by the operator is a derating factor only. That is, based on the operating history or known problems of the line, the operator can establish a lower MAOP for the line.

§192.619 (b) Maximum Safe Pressure

§192.619(b) No person may operate a segment to which paragraph (a)(4) of this section is applicable, unless overpressure protective devices are installed on the segment in a manner that will prevent the maximum allowable operating pressure from being exceeded, in accordance with §192.195.

- If the MAOP is established based upon the Maximum Safe Pressure, the line must be protected with overpressure protection required by §192.195, which states that some form of protection must be provided if a line is connected to a source that has a higher MAOP.

§192.619(c) Grandfather Clause

§192.619(c) The requirements on pressure restrictions in this section do not apply in the following instance. An operator may operate a segment of pipeline found to be in satisfactory condition, considering its operating and maintenance history, at the highest actual operating pressure to which the segment was subjected during the 5 years preceding the applicable date in the second column of the table in paragraph (a)(3) of this section. An operator must still comply with §192.611.

§192.619(c)

In our example, all relevant records were available and there was a pressure test conducted.

- Design = 720#
- Test Pressure = 1071#
- MOP = 850#

The MAOP of this line 850#, with the allowance of §192.619(c). The reason the line is allowed to operate above the working pressure of the ANSI 300 flange is because the component has proved it self in place under pressure and did not fail. This MAOP will be 850# as long as the line stays in satisfactory condition and there are no changes to components or changes to class location.

§192.619(c) Grandfather Clause

- §192.619(c) was implemented because pipelines had been operating safely prior to 1970, and intent was to not shut down pipelines that had operated safely at a pressure and shown to be in good condition – allow the status quo.
- Some MAOP had been established above 72% SMYS and without a "proper" pressure test.

§192.619 – MAOP Calculations- Plastic Pipelines

Lowest of the following:

- (a)(1) Design

For design of plastic pipe, we go to §192.121

- (a)(2) Test Pressure
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

§192.121 - Design of Plastic Pipe

$$P = \frac{2S}{(SDR-1)} \times DF$$

- P = Design Pressure
- S = Long Term Hydrostatic Strength - estimated tensile hoop stress that when applied continuously failure of the pipe at 100,000 hours (11.43 years) - (HDB - Hydrostatic Design Base)
- SDR = Standard Dimension Ratio = outside diameter /wall thickness

Hydrostatic Design Base

This table illustrates the typical Hydrostatic Design Bases for medium and high density polyethylene pipe at given temperatures.

It is important to understand that one of design considerations for plastic pipe is knowing the temperature in which the pipe is going to be exposed to.

As the temperature increases, the HDB decreases, thus as the temperature increases, the design pressure will decrease.

Piping Material	73 ºF	100 ºF	120 ºF	140 ºF
2406	1250	1250	1000	800
3408	1600	1250	1000	800

Plastic Pipe Specifications

- PE 3408 per ASTM-D2513
- 4 inch Diameter, SDR = 11
- Ambient Temperature is 84 ºF

$$P = \frac{2S}{(SDR-1)} \times DF$$

$$P = \frac{(2)(1250)}{(11-1)} \times 0.32 = 80 \text{ psi}$$

Effect of Operating Temperature

$P_{73\,^{o}F} = (2)(1600)/(11\text{-}1)x0.32 = 102$ psi

$P_{100\,^{o}F} = (2)(1250)/(11\text{-}1)x0.32 = 80$ psi

$P_{120\,^{o}F} = (2)(1000)/(11\text{-}1)x0.32 = 64$ psi

$P_{140\,^{o}F} = (2)(800)/(11\text{-}1)x0.32 = 51$ psi

- The equations above illustrate our pipe specifications at all temperatures.
- This shows as temperature increases, the design pressure decreases.

Design Pressure

The table illustrates the difference between medium density and high density PE pipe. The SDR for the table is 11. As the temperature increases the design pressure decreases. When the temperature exposure gets above 73 ºF the design pressure is the same for both types of pipe for the same SDR.

Piping Material	73 °F	100 °F	120 °F	140 °F
2406	80	80	64	51
3408	102	80	64	51

SDR = 11

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 80 psi
- (a)(2) Test Pressure
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

For Plastic - Test Pressure / 1.5

- Digging back through records we find a test pressure of 95#. The test pressure is divided by 1.5 in accordance with §192.619(a)(2)(i).
- Test Pressure - 1964 = 95 psi
- 95/1.5 = 63 psi

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 80 psi
- (a)(2) Test Pressure = 63 psi
- (a)(3) MOP during the 5 years preceding July 1, 1970
- (a)(4) Maximum Safe Pressure determined by the Operator

MOP

- High MOP during 5 years preceding 7/1/70

  Assume Operating Charts show high MOP is in 1968 at 45 psi

- Unless:
  - Tested in accordance §192.619(a)(2) after July 1, 1965 OR
  - Uprated in accordance with Subpart K of this part.
- The exception for using this 5 year window pressure is if the line was tested in the window or has gone through an uprate during this window. If the line has gone through either of these in this 5 year window the MOP is not applicable.

§192.619 - All Pipelines

- Lowest of the following:
- (a)(1) Design = 80 psi
- (a)(2) Test Pressure = 63 psi
- (a)(3) MOP during the 5 years preceding July 1, 1970 = 45 psi
- (a)(4) Maximum Safe Pressure determined by the Operator

§192.619 (a)(4) Maximum Safe Pressure

- The pressure determined by the operator to be the maximum safe pressure after considering the history of the segment, particularly known corrosion and the actual operating pressure.
- The Maximum Safe Pressure determination by the operator is a derating factor only. That is, based on the operating history or known problems of the line, the operator can establish a lower MAOP for the line.

For Distribution

- From §192.619 carry over determined MAOP
- High Pressure Distribution §192.621
- Low Pressure Distribution §192.623
- What about §192.619(c)? This paragraph doesn't apply because the lowest value was the 5 yr. MOP under §192.621(a)(3) which is 45 psi

§192.621 MAOP: High-Pressure distribution systems

- High Pressure Distribution System means a distribution system in which the gas pressure in the main is higher than the pressure provided to the customer.
- For High Pressure Distribution systems, we are typically talking about those systems operating in pounds. For example, a 45# or 60# system.
- Lowest of the following:
  (a)(1) Design
  (a)(2) 60# - unless service lines equipped with pressure limiting devices meeting §192.197(c)

§192.621 MAOP: High-Pressure distribution systems

- §192.621 has additional limitations for High Pressure Distribution systems, with §192.621(a) asking us to look at a number of parameters and using the lowest.
- §192.619(a)(1) requires us to look at design again. That is, in accordance with Subparts C and D of Part 192. Looking a the design of the pipe and the manufacturers rating of the components.
- Since we have already looked at the design, we won't need to go back through the calculations again. That value was 80#.
- In §192.621(a)(2) the pipeline is limited to 60# unless we provide the overpressure protection for customers as outlined in §192.197(c).

§192.621 MAOP: High-Pressure distribution systems

- Lowest of the following from our example:
  §192.619(a)(1) Design = 80#
  §192.619(a)(2) 60# - unless service lines equipped with pressure limiting devices meeting §192.197(c)
  §192.619(a)(3) 45#

  -Additional Limitations-

- §192.621(a)(3) 25# - Cast Iron Pipe if there are Unreinforced Bell and Spigot Joints
- §192.621(a)(4) The Pressure Limits of Joints
- §192.621(a)(5) Maximum Safe Pressure determined by the Operator (Must provide Overpressure Protection per §192.195 per §192.621(b))

§192.623 Low-Pressure Distribution Systems: Maximum and Minimum Allowable Operating Pressure

- Low Pressure Distribution System means a distribution system in which the gas pressure in the main is substantially the same as the pressure provided to the customer.
- For Low Pressure distribution systems we are typically talking about pipeline systems that carry ounces. Some of these systems carry up to as much as 2#.
- For Maximum Allowable Operating Pressure it is enough to make unsafe the operation of properly adjusted low-pressure gas burning equipment.

Minimum Allowable Operating Pressure

- Pressure lower than the minimum pressure at which the safe and continuing operation of any properly adjusted low-pressure gas burning equipment can be assured.
- The minimum MAOP is addressed in §192.623 because of dealing with such low pressures, line loss and other situations can reduce pressure where pilot lights can't even stay lit.
- Again as with the maximum, the operator is required to determine this and OPS has no set values.

Questions and Answers?